CLAIMS

1. A semiconductor device, comprising;

a substrate;

a lower electrode layer formed on said substrate;

an oxide dielectric layer formed on said lower electrode layer; and

an upper electrode layer formed ~~form——ed~~ on said oxide dielectric layer, wherein

said lower and upper electrode layers, as well as said oxide dielectric layer, are combined to compose an oxide dielectric capacitor, said lower electrode layer includes a conductive oxide layer, said conductive oxide layer consists of two adjacent layers formed in the same crystal structure and with the same elements, but are different ~~differently~~ in the composition ratio from each other, and one of said two adjacent layers, which is positioned at said substrate side, has an ~~includes~~ oxygen deficiency.

2. A semiconductor device in accordance with claim 1, wherein

a MOS transistor is disposed on said substrate, and said lower electrode layer is connected electrically to the source area or drain area of said MOS transistor.

3. A semiconductor ~~semic onductor~~ device in accordance with claim 1, wherein

said lower electrode layer consists of a conductive silicon layer, a conductive oxide layer having an ~~with~~ oxygen deficiency, and a conductive oxide layer ~~that are~~ stacked sequentially from said substrate side.

4. A semiconductor device in accordance with claim 1, wherein

said lower electrode layer consists of a conductive silicon layer, a non-oxide conductive layer for anti-diffusion, a conductive oxide layer having an ~~with~~ oxygen deficiency, and a conductive oxide layer ~~that are~~ stacked sequentially from said substrate side.

5. A semiconductor device in accordance with claim 4, wherein

a metallic layer is further formed between said anti-diffusion non-oxide conductive layer and said conductive oxide layer which has an ~~with~~ oxygen deficiency, said metallic layer is composed of at least one type of metal selected from a group consisting of platinum, ruthenium, and iridium.

6. A semiconductor device in accordance with claim 4, wherein

said anti-diffusion non-oxide conductive layer consists of a nitride including at least one type of metal selected from a group of Ti, Ta, Zr, Nb, V, and W.

7. A semiconductor device in accordance with claim 1, wherein

an oxide composing said double-layered conductive

a oxide layer is at least one type of compound selected from RuO_2 and IrO_2 having the rutile structure.

8. A semiconductor device in accordance with claim 7, wherein

a said conductive oxide layer having ~~with~~ said oxygen deficiency, which has said rutile structure, is

a characterized in ~~by~~ that the oxygen deficiency x in its chemical formula MO_{2-x} (M=Ru or Ir element) with said oxygen deficiency is larger than 0 and smaller than a value that can maintain said rutile structure stable.

Sub A1> 9. A semiconductor device in accordance with claim 1, wherein

an oxide composing said double-layered conductive oxide layer consists of at least one type compound selected from a group of $CaRuO_3$, $SrRuO_3$, and $SrTiO_3$ to which La is added by over 0.5 weight% to 4.0 weight% (included), and all of them having the perovskite structure.

10. A semiconductor device in accordance with claim 1, wherein

an oxide composing said double-layered conductive oxide layer has a mixed phase of at least one type compound selected from a group of $CaRuO_3$, $SrRuO_3$, and $SrTiO_3$ to which La is added by over 0.5 weight% to 4.0 weight% (included), and all of them having the perovskite structure, with an

sub A' concl'd? alkalline earth metal oxide composing said compound, that is, CaO or SrO.

11. A semiconductor device in accordance with claim 9, wherein

a said conductive oxide layer with having said ~~said~~ oxygen deficiency and consisting of an oxide of said perovskite a structure is characterized in ~~by~~ that the oxygen deficiency x in its chemical formula AMO_{3-x} (A and M indicate any of said Ca, Sr, Ti, and La elements) is larger than 0 and smaller than a value that can maintain the perovskite structure stable.

12. A semiconductor device in accordance with claim 1, wherein

said double-layered conductive oxide layer consists of ReO_3.

13. A semiconductor device in accordance with claim 12, wherein

a said conductive ~~conduct ive~~ oxide layer having ~~with~~ said oxygen a deficiency and consisting of ~~said~~ ReO_3 is characterized in ~~by~~ that the oxygen deficiency x in its chemical formula ReO_{3-x} with said oxygen deficiency is larger than 0 and smaller than a a value that can maintain the ReO_3 ~~ReO_3~~ structure stable.

14. A semiconductor device in accordance with claim 1, wherein

a said conductive oxide layer ~~with~~ having said oxygen deficiency is 10nm or above in thickness.

15. A semiconductor device in accordance with claim 1, wherein

said oxide dielectric layer is formed with one compound selected from lead zirconate titanate, lead barium zirconate titanate, and strontium barium titanate.

16. A semiconductor device in accordance with claim 1, wherein

said oxide dielectric layer consists of bismuth-system layered ferroelectrics.

17. A method for manufacturing a semiconductor device, including a process for forming a conductive oxide layer with oxygen deficiency by sputtering or evaporating elements composing said conductive oxide in a non-oxidizing atmosphere, then forming a conductive oxide layer on said conductive oxide layer with said oxygen deficiency, thereby forming a lower electrode layer on a substrate; a process for forming an oxide dielectric layer on said lower electrode layer; and a process for forming an upper electrode layer on said oxide dielectric layer, wherein

said lower electrode layer consists mainly of two conductive oxide layers formed in the same crystal structure and consisting of the same element, but different from each other in oxygen composition ratio, and

Sub A' cont'd. said lower and upper electrode layers, as well as said oxide dielectric layer are combined thereby composing an oxide dielectric capacitor.

a 18. A method of ~~for~~ manufacturing a semiconductor device in accordance with claim 17, wherein

at least part of a MOS transistor is formed on said substrate before said lower electrode layer is formed so as to be connected electrically to the source area or drain area of said MOS transistor.

a 19. A method of ~~for~~ manufacturing a semiconductor device in accordance with claim 17, wherein

said conductive oxide layer with said oxygen deficiency formed in said double-layered conductive oxide layer is formed with the sputtering method and said non-oxidizing atmospheric gas is an argon gas (Ar) of 3N (99.9%) or over in purity.

a 20. A method of ~~for~~ manufacturing a semiconductor device in accordance with claim 17, wherein

a said conductive oxide layer having ~~with~~ said oxygen deficiency, which is formed in said double-layered

a conductive oxide layer, is then formed with a ~~the~~ sputtering

a method or a ~~the~~ vacuum deposition method, and said non-

a oxidizing atmospheric gas is in a vacuum state of 1 μTorr or below into which no oxidizing gas consisting of any of oxygen

(O_2), nitric monoxide (N_2O), nitric dioxide (NO_2), and ozone (O_3) is introduced intentionally.

Sub A3> 21. A method for manufacturing a semiconductor device in accordance with claim 17, wherein

said conductive oxide layer with said oxygen deficiency, which is formed in said double-layered conductive oxide layer, is then formed with the sputtering method or the vacuum deposition method, and said non-oxidizing atmospheric gas consists of at least one type selected from oxygen (O_2), nitric monoxide (N_2O), nitric dioxide (NO_2), and ozone (O_3), and the pressure or partial pressure of said gas is 10 μTorr or below.

22. A semiconductor device, comprising;

a substrate;

a lower electrode layer formed on said substrate;

an oxide dielectric layer formed on said lower electrode layer; and

an upper electrode layer provided on said oxide dielectric layer, wherein

said lower and upper electrode layers, as well as said oxide dielectric layer, are combined to compose an oxide dielectric capacitor, and said lower electrode layer includes an aluminum titanium nitride layer.

a 23. A semiconductor device ~~devic e~~ in accordance with claim 22, wherein

a MOS transistor is disposed on said substrate, and said lower electrode layer is connected electrically to the source area or drain area of said MOS transistor.

24. A semiconductor device in accordance with claim 22, wherein

said lower electrode layer consists of a conductive silicon layer, an aluminum titanium nitride layer, and a metallic layer that are stacked sequentially from said substrate side.

25. A semiconductor device in accordance with claim 24, wherein

a conductive oxide layer is further formed on said metallic layer in said lower electrode layer.

26. A semiconductor device in accordance with claim 24, wherein

a said metallic layer consists of at least one type of

a metal element selected from a group consisting of platinum, iridium, ruthenium, and rhenium.

27. A semiconductor device in accordance with claim 25, wherein

a said conductive oxide layer consists of one type of

a compound selected from a group consisting of IrO_2, ~~of IrO~~ $_2$, RuO_2, $SrRuO_3$, and ReO_3.

a 28. A semiconductor device in accordance ~~accor dance~~ with claim 22, wherein

the composition of said aluminum titanium nitride layer is represented by a chemical formula of $(Ti_{1-x} Al_x)_{1-y} N_y$ ~~$(Ti_{1-x} Al_x)_{1-y} N_y$~~, and x is over 0.2 to 0.5 (included) and y is over 0.4 to 0.6 (included).

29. A semiconductor device in accordance ~~accordanc e~~ with claim 22, wherein

said oxide dielectric layer is formed with one compound selected from lead zirconate titanate, lead barium zirconate titanate, and strontium barium titanate.

30. A semiconductor device in accordance with claim 22, wherein

said oxide dielectric layer consists of bismuth-system layered ferroelectrics.

sub A4> 31. A method for manufacturing a semiconductor device, including;

a step for forming a lower electrode layer including an aluminum titanium nitride layer on a substrate by sputtering in a nitridizing atmosphere; a step for forming an oxide dielectric layer on said lower electrode layer; and a step for forming an upper electrode layer on said oxide dielectric layer, wherein

both lower and upper electrode layers, as well as said oxide dielectric layer are combined thereby composing an oxide dielectric capacitor.

a 32. A method of ~~for~~ forming a semiconductor device in accordance with claim 31, wherein

at least part of an MOS transistor is formed on the surface of said substrate before said lower electrode layer is formed, and said lower electrode layer is formed so as to be connected electrically to the source or drain area of said MOS transistor.

a 33. A method of ~~for~~ forming a semiconductor device in accordance with claim 31, wherein

said nitridizing atmosphere used for forming said

a aluminum titanium nitride layer prevents ~~preventing~~ oxygen diffusion

a and oxidation and includes a nitrogen gas of 10 to 90 mol% in an inactive gas.

a 34. A method of ~~for~~ forming a semiconductor device in accordance with claim 31, wherein

a temperature for forming said aluminum titanium

a nitride layer to prevent ~~preventing~~ oxygen diffusion and oxidation is 550 ℃ or below.

Sub A5> 35. A semiconductor device, including;

first area consisting of a semiconductor material; second area connected to said first area and consisting of said first conductive material; third area connected to said second area and consisting of said second conductive material; fourth area connected to said third area and consisting of an oxide dielectric material; and fifth area

Sub A[6] 7 Cont'd.

connected to said fourth area and consisting of a conductive material, wherein

the material composition at the interface of said first area adjacent to said second area is approximately equal to the average material composition of said first area, and the material compositions at the interface of said second area adjacent to said first area, as well as to said third area is approximately equal to the average material composition of said second area.

36. A semiconductor device, including;

first area consisting of a conductive semiconductor material; second area connected to said first area and consisting of said first conductive material; third area connected to said second area and consisting of said second conductive material; fourth area connected to said third area and consisting of an oxide dielectric material; and fifth area connected to said fourth area and consisting of a conductive material, wherein

the average resistivity of said first area is approximately equal to the resistivity of said semiconductor material and the average resistivity of said second area is approximately equal to the resistivity of said first conductive material.